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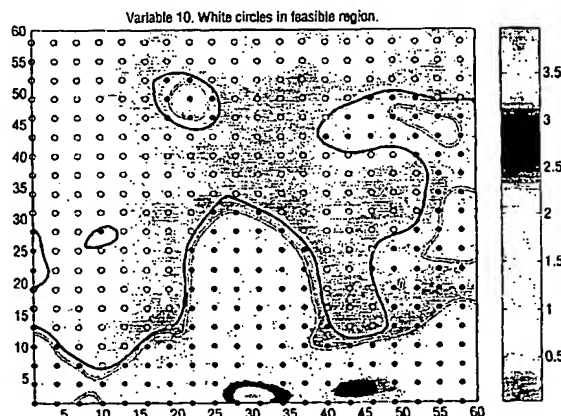
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[Continued on next page]

(54) Title: DESIGN BY SPACE TRANSFORMATION FROM HIGH TO LOW DIMENSIONS



(57) Abstract: A method is provided for transforming data from a high-dimensional to low-dimensional design space, and for inspecting the transformed data in such a manner as to permit effective navigation and exploration of the high-dimensional design space. Conveniently, an optimum/conditional value for a prescribed functional representation of the transformed data can be derived by visual inspection of a 2-D image map representation of the transformed data. Significantly, the invention has utility for various aircraft design applications and although this technology has been developed with reference to aircraft aerodynamic design in particular, the design space visualisation and curve-fitting technology developed is general. It should therefore be equally applicable to other disciplines such as cost analysis, structures and computational electromagnetics, in which expensive analysis tools are used to find optima for complicated design problems. It is expected to be particularly useful in multi-disciplinary design and situations where there are multiple optima in the design space.

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— *with international search report*

# INTERNATIONAL SEARCH REPORT

GB2004/004248

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 G06F17/60 G06T17/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 G06F G06T		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the International search (name of data base and, where practical, search terms used) EPO-Internal, INSPEC, WPI Data, PAJ		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EL-BELTAGY M A ET AL: "Topographical mapping assisted evolutionary search for multilevel optimization" PROCEEDINGS OF THE 1999 CONGRESS ON EVOLUTIONARY COMPUTATION-CEC99 (CAT. NO. 99TH8406), PROCEEDINGS OF THE 1999. CONGRESS ON EVOLUTIONARY COMPUTATION-CEC99, WASHINGTON, DC, USA, 6-9 JULY 1999, 6 July 1999 (1999-07-06), pages 660-665 Vol. 1, XP002270681 1999, Piscataway, NJ, USA, IEEE, USA ISBN: 0-7803-5536-9	1-7, 11-13
Y	the whole document <div style="text-align: center;">----- -/--</div>	9
<div style="display: flex; justify-content: space-between;"> <span><input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.</span> <span><input type="checkbox"/> Patent family members are listed in annex.</span> </div>		
* Special categories of cited documents : <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>*8* document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search <div style="text-align: center;">16 December 2004</div>		Date of mailing of the international search report <div style="text-align: center;">12/01/2005</div>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer <div style="text-align: center;">Rockinger, O</div>

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	C. M. E. HOLDEN, R. DAVIES, AND A. J. KEANE: "Optimization Methodologies in Conceptual Design" PROC. 9TH AIAA/ISSMO SYMP. ON MULTIDISCIPLINARY ANALYSIS AND OPTIMIZATION, 2002, pages 1142-1152, XP009026008 Atlanta	9
A	* Chapter 3: "The Conceptual Design Problem" *	1-8, 11-13
A	TINO P ET AL: "Hierarchical GTM: constructing localized nonlinear projection manifolds in a principled way" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, MAY 2002, IEEE COMPUT. SOC, USA, vol. 24, no. 5, May 2002 (2002-05), pages 639-656, XP001141214 ISSN: 0162-8828 the whole document	1-9, 11-13

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

Continuation of Box II.2

Claims Nos.: 10,14

No meaningful search possible because claims 10 and 14 contain references to i) the whole description and ii) the complete set of drawings, respectively.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

**INTERNATIONAL SEARCH REPORT**

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**Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 10, 14  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this International application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all/ searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.